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The intercarotid or alar fascia, other cervical fascias, and their adjacent spaces – a plea for clarification of cervical fascia and spaces terminology

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Abstract

Due to varying descriptions and terminology of fascias of the neck, medical advice relying on this basic knowledge is insufficient. Our goal was to provide a precise anatomical description of cervical fascias and spaces with special focus on the intercarotid fascia, or the alar fascia. One hundred bodies donated to science embalmed with Thiel's method were investigated, cervical fascias were dissected layer by layer, and the results were documented by photography, with a focus on the intercarotid fascia. In addition, we performed a review of recent literature concerning cervical surgical interventions, radiological diagnostic pathways, and basic anatomical works focusing on core information on anatomical relations of cervical fascias and spaces. In another 10 bodies donated to science, the spaces of the neck were injected with coloured latex under ultrasound guidance, dissected, and documented by photography. The intercarotid fascia was a constantly developed connective tissue interconnecting the carotid sheath of both sides. In 52 of 100 specimens (52%) it crossed to the opposite side without any fusion to the ventrally situated visceral fascia. Fusion with the visceral fascia was found in 48%, either at the lateral border of the pharynx or on its dorsal side. The results of our dissections strengthen the precise description of the cervical fascias provided by Grodinsky and Holyoke in 1938. Spaces can be confirmed as described by Hafferl in 1969. The international anatomical and ENT societies should codify a unified anatomical terminology of the cervical spaces and fascias to prevent varying interpretations in the future.

KEYWORDS

alar fascia, cervical abscess, cervical fascia, fascia alaris, fascia cervicalis, fascia intercarotica, head and neck, intercarotid fascia, neck anatomy

1 | INTRODUCTION

A precise knowledge of the macroscopic anatomy of the neck is fundamental for every physician dealing with pathological entities of this part of the body. It is especially important in the daily clinical routine of ear, nose and throat (ENT) physicians, head and neck surgeons, anaesthesiologists, and radiologists to know the systemic anatomy and topographical relationships of the organs and fascias of the head and neck.

In a review of recent literature concerning cervical surgical interventions, radiological diagnostic pathways, and even single case reports, entirely different terminology for anatomical structures was demonstrated from case to case. As a consequence, medical advice relying on this basic knowledge is also insufficient, or confusing (Brito-Mutunayagam *et al*., 2007; Karkos *et al*., 2007; Pinto *et al*., 2008; Johnston *et al*., 2009; Schuler *et al*., 2009; Lanisnik and Cizmarevic, 2010; Uzomefuna *et al*., 2010; Lyle *et al*., 2011; Hedge *et al*., 2012; Kang *et al*, 2012; Ozurekci *et al*., 2015; Tuncturk *et al*., 2015). The basic anatomical information in the majority of reviewed publications is simply given in a few sentences in the introduction of articles or book chapters; thereby, the reader, whose focus is on the main topic of the article, does not get the necessary and adequate core information.

The differences in anatomical terminology between Anglo-American and Central-European medical study may be the underlying reasons for this problem (Testut, 1902; Charpy, 1912; Rouviére, 1927; Grodinsky and Holyoke, 1938; Lanz and Wachsmuth, 1955; Hollinshead, 1982; Platzer, 1987; Federative Committee on Anatomical Terminology 1998,2011; Putz and Pabst, 2000; Nash *et al*., 2005; Ozlugedik *et al*., 2005; Prometheus, 2005; Tillmann, 2005; Debnam and Guha-Thakurta, 2012; Hammer *et al*., 2012; Vollmann *et al*., 2012; Weiglein, 2012; Feigl, 2015; Scali *et al*., 2015; Stecco, 2015; Gavid *et al*., 2018). However, in the modern age of molecular medicine and research, this confusion of basic macromorphological knowledge needs to be clarified. The aim of this anatomical study and review of literature was to identify such deficits and to provide a more precise anatomical description based on our research on bodies donated to science. Our focus was on the fascias in the ventral regions of the neck, with a special interest in the 'intercarotid fascia'. We compared two terminological approaches to fascias: that of the Central European Terminology according to Hafferl (1969) and that of the FCAT, to evaluate the differences and similarities in these two terminologies. The topography of the spaces was examined according to the terminology of Hafferl (1969) and the description of Grodinsky and Holyoke (1938).

2 | MATERIALS AND METHODS

2.1 | First part

In 100 bodies dStonated to science (bdts) to the Division of Macroscopic and Clinical Anatomy of the Medical University Graz under its Anatomical Donation Program's approval of the University of Graz and according to the Styrian burial law, we delineated cervical fascias by dissecting the neck layer by layer. We examined 59 female (51–93 years, median 74 years) and 41 male bdts (45–89 years, median 72.51) during two dissection courses of third semester students. Combined female and male specimen ages ranged from 45 to 93 years (mean: 74 years). All of them were embalmed according to Thiel's method, which preserves a natural character of tissues (Thiel, 1992a; 2002; Joy *et al*., 2015). The embalming method provides very lifelike conditions and it is feasible to dissect the fascias on the neck without creating any artefacts. Specimens with any pathological changes such as neck surgery were excluded. The dissections were performed with great care by a board-certified anatomist with more than 24 years of dissection experience who has dissected more than 1,000 bdts preserved using this method. In addition, he has specialized in the fascias of the neck as a result of previous investigations (Feigl *et al*., 2006; 2007; Feigl, 2015). The anatomy of the fascias was documented by photography. Dissection started with a median sagittal skin incision and was extended cranially to the inferior margin of the mandibula and caudally to the clavicular level. The skin was removed carefully as far as the margin of the trapezius muscle. Soft connective tissue and spaces were dissected carefully using the blunt part of the tweezers or of the scalpel as well as sharply with the blade of the scalpel. Fascias could be identified and dissected by special positioning. As an example, to dissect the right side of the anterior and lateral cervical regions, the neck was extended and turned to the left side. With this consecutive tension, the fascias could be dissected easily. The fascia intercarotica could be dissected by a blade and smoothly by lateral positioning of the vagina carotica and medial positioning of the viscera. The fascia alaris was identified and dissected by ventral extension of the vagina carotica with the tweezers. An incision dorsal to the vagina carotica provided a safe identification of sagittal septa.

2.2 | Second part

The spaces of the neck were injected with diluted latex regularly used for intra-arterial injections during the embalming procedure (Thiel, 1992b) on an additional 10 bdts embalmed with Thiel's method, but not including the intra-arterial injection (Thiel, 1992b). Intra-arterial injection would create too many artefacts in ultrasound imaging, therefore making precise needle guidance and precise injection almost impossible. With no arterial injection, Thiel's method provides good conditions for ultrasound (Benkhadra *et al*., 2009). To leave the neck region untouched, these 10 cadavers were embalmed via the right femoral artery. The injections were performed under ultrasound guidance (Acuson X150; linear probes VF 13-5, VF 10-5; Siemens, Munich, Germany) and with a 5-mm 22-gauge needle (Sonoplex, Pajunk, Geisingen, Germany). The needle tip position for suprasternal injection was medial to the sternocleidomastoid muscle at the level where the omohyoid muscle passes behind it. Pretracheal space injection was at the same level but dorsal to the sternohyoid muscle. The 'danger space' was injected behind the common carotid artery at the C6 level and the prevertebral space was injected at the C5 level. For both the suprasternal and prevertebral spaces, 10 ml of green latex was injected in each, 10 ml of blue latex into the pretracheal space, and 10 ml of red latex in the 'danger space'; finally, green latex was injected into the prevertebral space. Dissections were performed 2 weeks after injection to ensure latex hardening and to avoid unwelcome spread and invalid results. Dissection was performed layer by layer to document the precise spread of the latex.

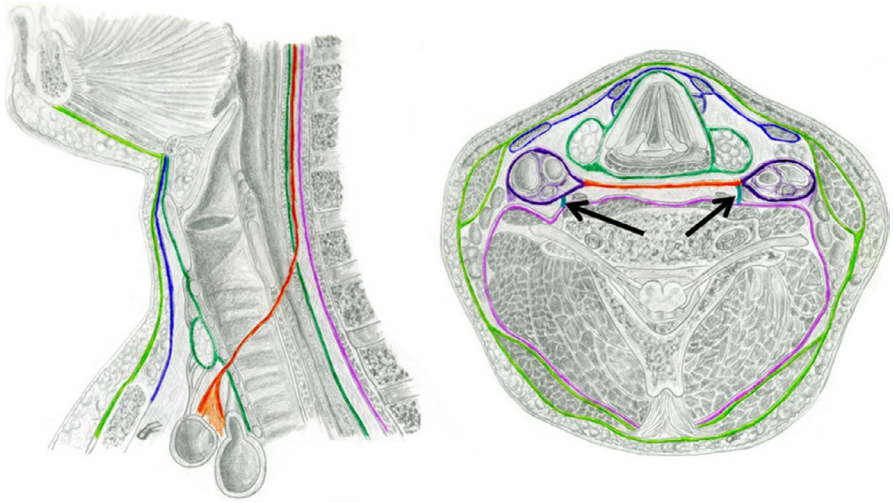


FIGURE 1 Drawings of a median (mediosagittal) and transverse cross-section with the cervical fascias exposed: fascia cervicalis superficialis (light green), fascia cervicalis media (blue), fascia buccopharyngea (green), fascia intercarotica (orange), fascia prevertebralis (pink), and fascia alaris (turquoise). The fascia alaris is marked by arrows as well

Additionally, we performed a review of recent literature concerning cervical surgical interventions, radiological diagnostic pathways, and basic anatomical work focusing on core information about anatomical relations of cervical fascias and spaces.

3 | RESULTS

Each different layer is listed and described from superficial to deep in our 'Central European Terminology' (Figure 1). In addition, it should be noted that the authors have followed and retained the original Latin terminology; the corresponding fascias according to International Terminologia Anatomica (1998) and the interpretation of Stecco (2015) are listed (Table 1).

3.1 | Fascias

3.1.1 | Fascia cervicalis superficialis (corresponding to the superficial layer of deep cervical fascia)

This superficial body fascia envelops the sternocleidomastoid and trapezius muscles and continues either cranially into the fascia parotideomasseterica or caudally into the fascia thoracis superficialis,

TABLE 1 Comparison of the International anatomical nomenclature with the terminology used in the present paper (Central European Terminology): please be aware that not all terms are found in the two classifications. The asterisk marks the fascias described by Grodinsky and Holyoke (1938)

Central European terminology (Hafferl/Thiel)	International terminology	Fascia interpretation according to Stecco
Skin	Skin	Skin
Panniculus adiposus (subcutaneous fat pad)		
Platysma		Superficial fascia or fibromuscular layer
Fascia cervicalis superficialis (superficial cervical fascia)	Superficial layer (lamina superficialis)	Superficial lamina or investing layer (layer I) of deep cervical fascia
Fascia cervicalis media (middle cervical fascia)	-	Middle lamina (layer II) of deep cervical fascia
Fascia buccopharyngea (visceral fascia; buccopharyngeal fascia)	Pretracheal layer (lamina pretrachealis)	Visceral fascia
Vagina carotica	Carotid sheath	-
Fascia cervicalis profunda	-	-
Lamina superficialis: fascia intercarotica (superficial layer of deep cervical fascia)	-	-
Lamina profunda: fascia prevertebralis	Deep layer	Deep lamina (layer III) or prevertebral fascia
Fascia alaris; *new recommendation*: septum sagittale cervicis/cervicale	*New recommendation*: sagittal septum of neck	

which covers the pectoralis major muscle. This fascia is a strong and—especially in the anterior cervical region—well-developed tissue, whereas in the lateral cervical region it cannot be dissected without damage. Medial to the sternocleidomastoid muscle, the fascia cervicalis superficialis inserts at the ventral plane of the manubrium of the sternum and membrana sterni. The sensory nerves of the area nervosa or the former punctum nervosum pierce this fascia at different levels. However, with the exception of the supraclavicular nerves, all others lie close to each other. The supraclavicular nerves themselves enter in the subcutaneous layer far caudal to the area nervosa. At clavicular level, the three nerves (medial, intermediate, and lateral) often visibly perforate the fascia separately (Figures 1 and 2).

3.1.2 | Fascia cervicalis media

The fascia cervicalis media covers and envelops the infrahyoid muscles, which are also called the musculi detractores larynges, or 'strap muscles' in ENT surgery. It has a strong and aponeurotic character, mainly in the cranial and medial areas. As the fascia is limited to the lateral border of the omohyoid muscles, it is only visible in the medial corner of the lateral cervical triangle. This is the area in which the omoclavicular triangle is formed and the external jugular vein must pass through the fascia on its way to its termination at the confluence of the internal jugular and subclavian veins, called 'venous confluence/angle of Pirogoff'. Its caudal insertion is at the dorsal aspect of either the manubrium of the sternum or the clavicle (Figures 1 and 3).

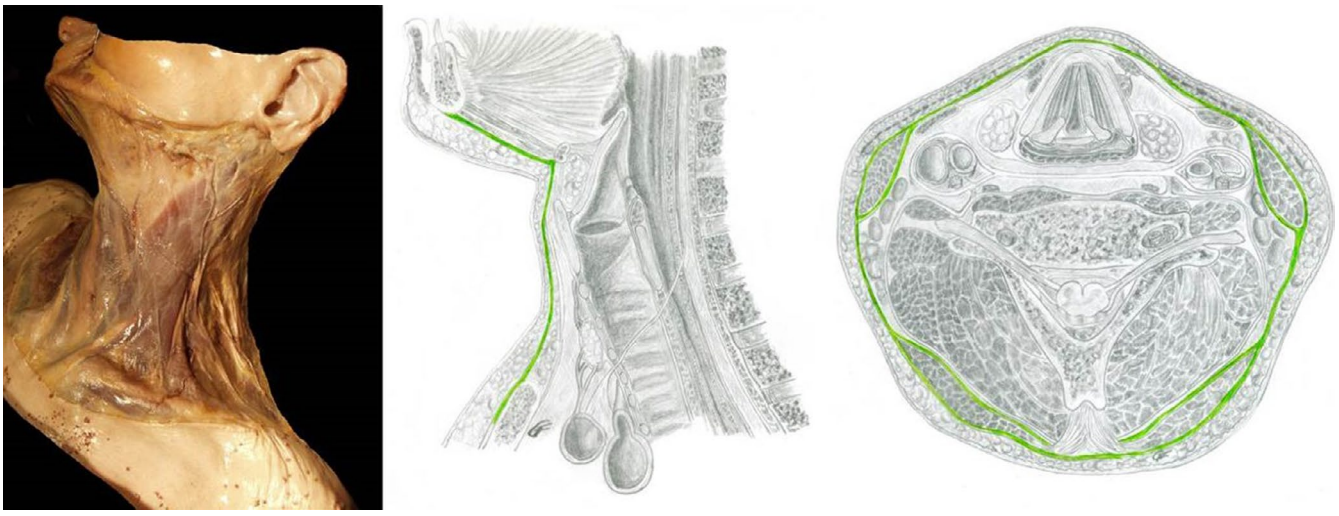


FIGURE 2 Fascia cervicalis superficialis dissected in the anterior, lateral, and posterior regions of the neck including the sensory nerves of the cervical plexus piercing this fascia at different levels. The fascia is visible as the light green structure in the drawings

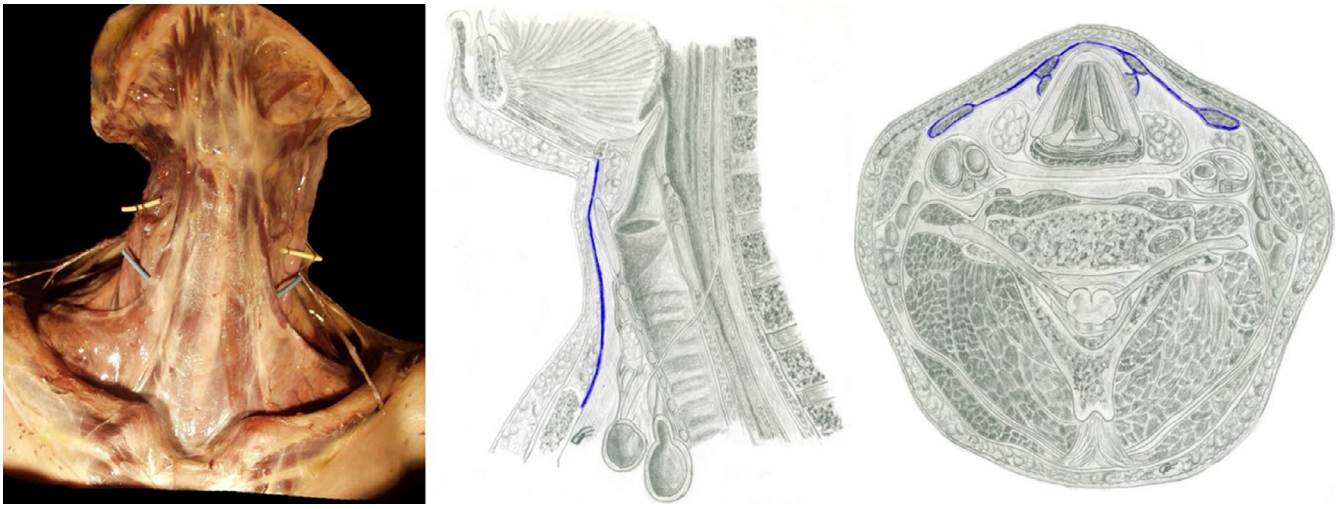


FIGURE 3 Dissection of an entire fascia cervicalis media between the two omohyoid muscles: a blue probe is positioned underneath the fascia in the pretracheal space. Fascia is marked blue in the graphic scheme

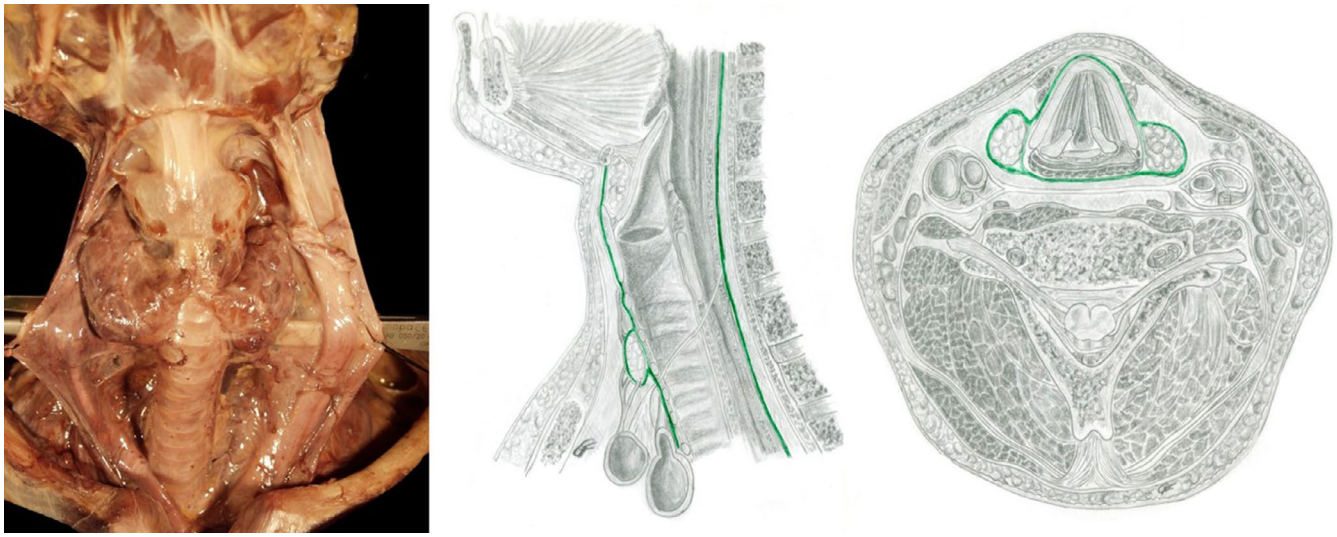


FIGURE 4 Fascia buccopharyngea/visceralis covering the organs: larynx, trachea, thyroid gland, pharynx, oesophagus

3.1.3 | Fascia visceralis (fascia buccopharyngea; corresponding to the middle layer of the deep cervical fascia)

This covers the viscera of the neck, including pharynx, larynx, thyroid gland, and oesophagus, and is a fascia which can be removed from the muscle layers of the pharynx as it envelops these muscles.

3.1.4 | Vagina carotica (carotid sheath)

A strong connective tissue tunnel surrounds three large structures of the neck: the common carotid artery, internal jugular vein, and the vagus nerve. As described, all three have their own tunnel. We can confirm this description in the area of the common carotid artery. After the carotid bifurcation, where the external and internal carotid arteries are formed, it is not that clear whether the tunnels continue (Figures 1 and 4). However, in close relation to the carotid sheath or part of the ventral wall of the sheath, the superior root of the ansa cervicalis profunda runs ventrally and caudally.

3.1.5 | Fascia intercarotica (corresponding to the alar fascia)

This fascia is a partially thick wall composed of dense regular connective tissue and is oriented in the frontal plane. It crosses the median plane between the carotid sheaths of both sides. On its way medially, it passes dorsal to the pharynx. However, this fascia may be fused with the buccopharyngeal fascia lateral or dorsal to the pharynx. In 52 of 100 specimens (52%) the intercarotid fascia reached the opposite side without any fusion to the ventrally situated visceral fascia. On its way caudally, the fascia follows the course of the carotid arteries ventrally. As a consequence, the visceral organs (trachea, oesophagus), unpaired thyroid plexus, and middle thyroid vein must pass this fascia from cranial and ventral to caudal and dorsal. In addition, the inferior thyroid artery and the recurrent laryngeal nerve take the opposite course to reach their final targets of blood supply, or innervation, respectively (Figures 1 and 5). Fusion with the buccopharyngeal fascia was documented in 48% of cases. Here, we could find a fusion at the lateral border of the pharynx or at the dorsal aspect of the pharynx (Figure 6). This explains the continuation of the pretracheal space into the retropharyngeal space but without a continuation into the 'danger space' located dorsal to the intercarotid fascia.

3.1.6 | Fascia prevertebralis (corresponding to the deep layer of the deep cervical fascia)

A strong layer of connective tissue covers the prevertebral muscles (longus capitis and longus colli muscles) as well as the scalene muscles and the levator scapulae muscle (Figures 1 and 7). This layer sometimes fuses with the anterior longitudinal ligament in the median plane. This fascia runs laterally and lies superficial to the subclavian artery and the brachial plexus, which both arrive between the anterior and middle scalene muscles in the posterior interscalene gap (hiatus scalenorum posterius—other terms: fissura interscalenica, hiatus scalenicus, fissura scalenorum) in the lateral cervical triangle (Musil *et al*., 2018). Caudally and laterally, the fascia elevates and inserts in the fascia of the subclavius muscles, i.e. in the fascia clavipectoralis. It continues dorsally and envelops the deep back muscles of the neck. In the posterior cervical region, in the extension of the trapezius muscle, where the fascia cervicalis superficialis must split to envelop the trapezius muscle, both fascias fuse. The fascia prevertebralis envelops two important nerve structures: the sympathetic trunk and the phrenic nerve. The sympathetic trunk may be covered by a thin layer of connective tissue, which is like a double layer of the fascia prevertebralis located ventrally, explaining why the trunk can be elevated gently from the fascia prevertebralis in most cases. Another important fact is that the fascia

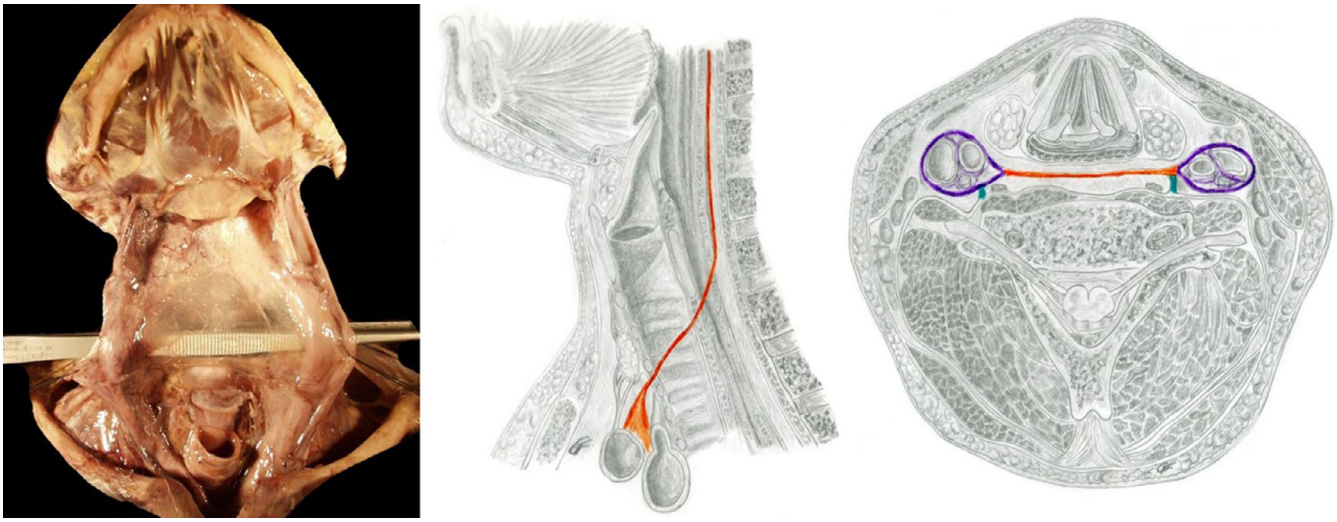


FIGURE 5 The fascia intercarotica is easily identifiable and connects the two common carotid arteries; the tweezers are positioned behind ('danger space') the fascia which is marked orange in the graphic scheme

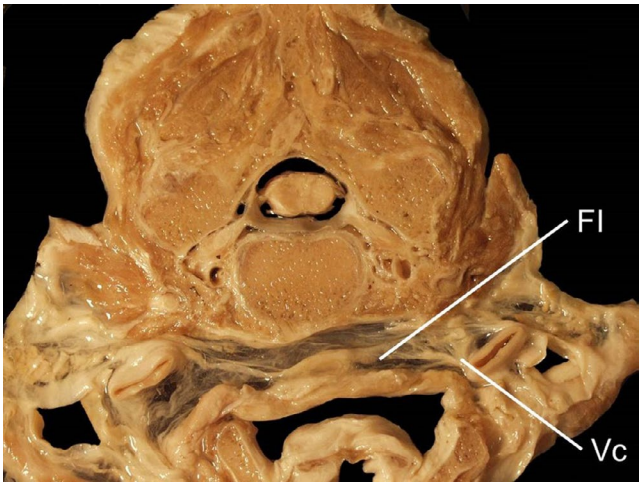


FIGURE 6 The vagina carotica (Vc) is marked at the border to the fascia intercarotica (FI) which crosses dorsally to the pharynx to the contralatral side. The fusion of the FI with the fascia buccopharyngea is visible in the median plane

prevertebralis splits at the level of the carotid tubercle (of Chassaignac) of C6. The fascia follows the inferior oblique part of the longus colli muscle medially and the anterior scalene muscle laterally, which leaves no posterior wall between these two muscles. As a consequence, the scalenovertebral triangle, which is located between these two muscles, continues dorsally and has a connection to the prevertebral space and even the intervertebral foramen. This is a very important topography because the intervertebral foramen is where the prevertebral space and the epidural space connect (Figures 1 and 7).

3.1.7 | Fascia alaris

The fascia alaris is a thick wall of dense connective tissue which extends between the carotid sheath and the fascia prevertebralis more or less in a sagittal plane. It extends cranial to the skull base and caudal to the level of C6 or C7. The fascia is also a guide for the inferior root of the ansa cervicalis profunda (Figures 1 and 8). The inferior root can pass the internal jugular vein medially or laterally; the fascia alaris may be developed more medially (Figure 1) or laterally (Figure 8).

3.2 | Spaces

3.2.1 | Spatium suprasternale

This space is located between the fascia cervicalis superficialis and fascia cervicalis media. The latex stayed medially and did not pass behind the sternocleidomastoid muscle laterally (Figure 9a,b). Cranial spread stopped at the inferior border of the thyroid cartilage.

3.2.2 | Spatium pretracheale

The latex was visible underneath the fascia cervicalis media. Caudal spread was documented but the latex did not spread laterally behind the sternocleidomastoid muscle into the lateral cervical triangle/region. The thyroid gland was surrounded in all cases (Figure 10a–c). No dorsal spread was documented because of the fascia intercarotica. In addition, the latex stayed lateral to the visceral organs and did not spread dorsally to the oesophagus or pharynx.

'Danger space'. the red latex spread in a craniocaudal direction but did not reach the lateral cervical triangle/region. It was clearly identifiable dorsal to the fascia intercarotica (Figure 11a,b). Latex was visible as low as the cranial part of the posterior mediastinum (alias the superior mediastinum according to the *Terminologia anatomica*).

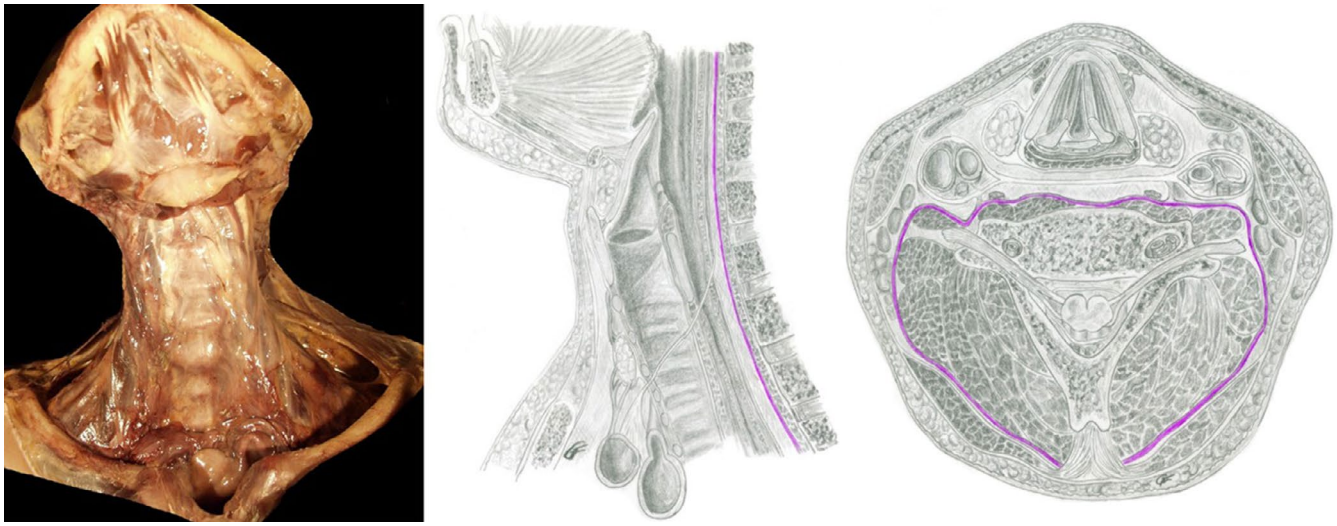


FIGURE 7 The fascia prevertebralis covering the deep cervical muscle layer and the brachial plexus entering the lateral cervical triangle/region via the posterior interscalene gap

FIGURE 8 The turquoise *fascia alaris*, marked with an arrow, is shown as a sagittally oriented fascial layer between the *vagina carotica* (purple) and *fascia prevertebralis* (pink) (a). The dissection photos show the fascia as the lateral border of the medially located 'Danger space' (b,c). The tweezers are inserted in the 'Danger space' cranially (c)

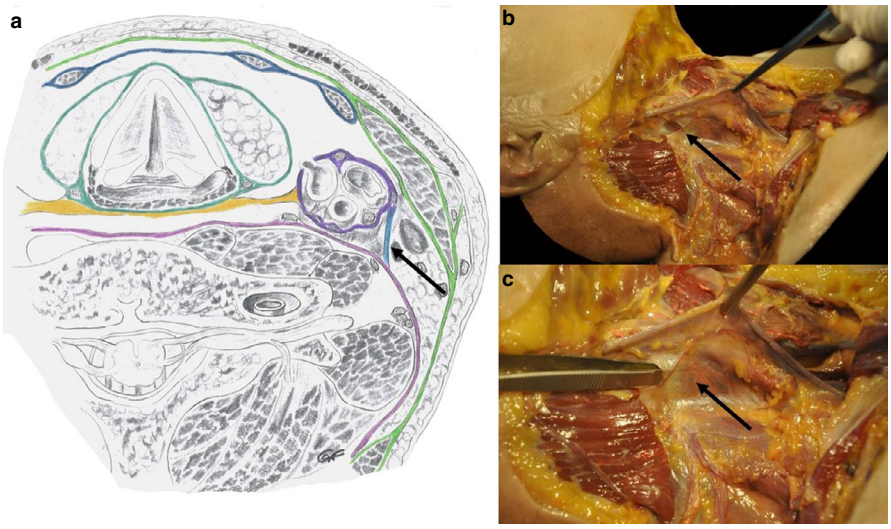
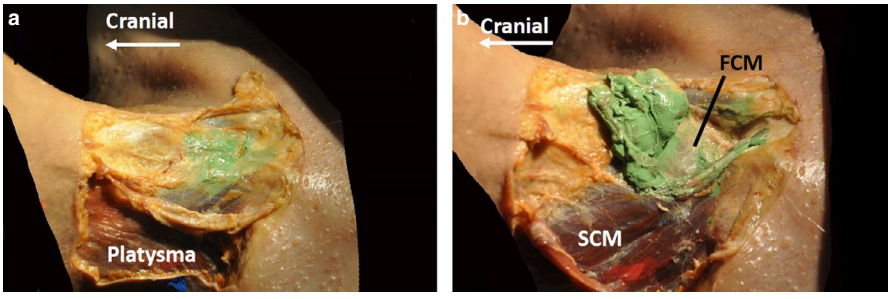


FIGURE 9 View from the ventral right side: green latex is visible in the suprasternal space underneath the intact fascia cervicalis superficialis. The platysma muscle is retracted laterally (a). (b) The elevated latex mass and the exposed fascia cervicalis media (FCM). SCM, sternocleidomastoid muscle



3.2.3 | Spatium prevertebrale

The green latex elevated the fascia prevertebralis and was visible medially on the longus colli muscle and laterally on the anterior scalene muscle as well as the levator scapulae muscle (Figure 11b). A distribution of green latex into the scalenovertebral triangle dorsal to the anterior scalene muscle was not confirmed.

4 | DISCUSSION

The clearest outcome is the incompatibility of our results with the terminology found in *Terminologia anatomica* (1998). Instead, the dissections and injections confirm previous results and descriptions by Feigl (2015) and recently published results of Gavid *et al.* (2018) concerning the alar fascia or the fascia intercarotica, respectively.

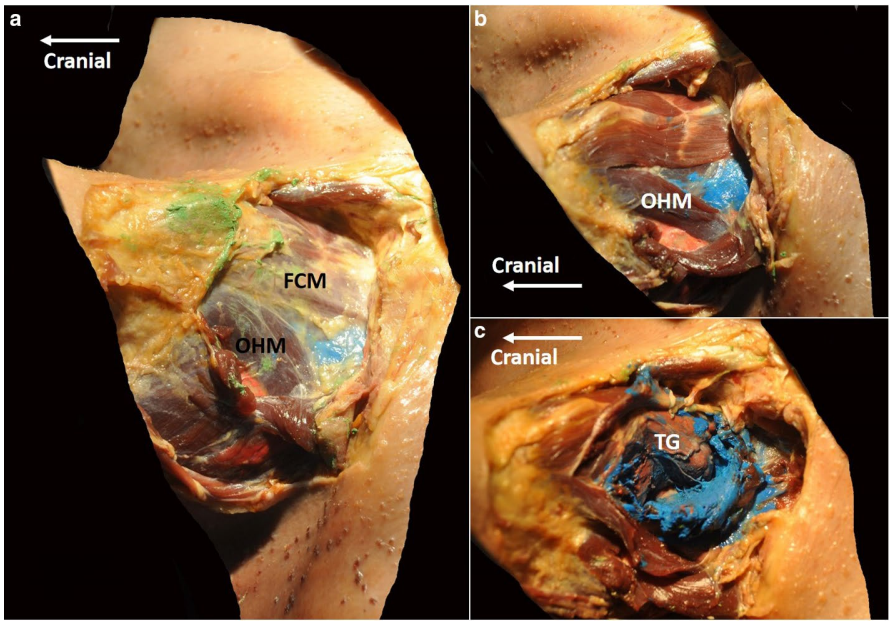


FIGURE 10 View from the ventral right side: the left image (a) shows the fascia cervicalis media (FCM) with its lateral extention to the lateral margin of the omohyoid muscle (OHM). The blue latex injected into the pretracheal space is visible. (b) The latex; the FCM is resected. Retraction of the infrahyoid muscle group exposed the blue latex in the pretracheal space surrounding the thyroid gland (TG) in (c)

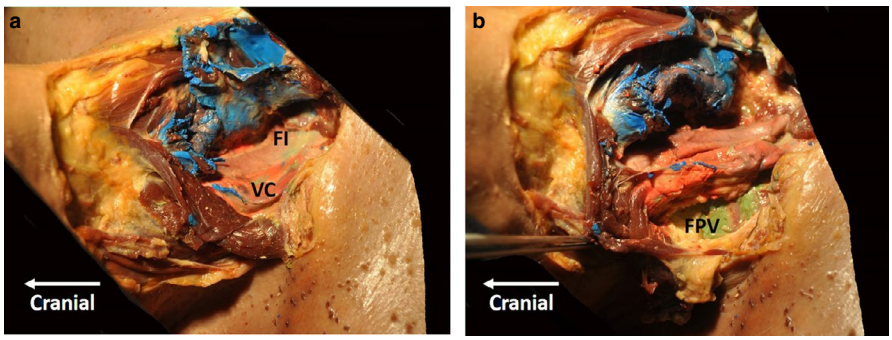


FIGURE 11 View from the ventral right side: the blue latex in the pretracheal space is elevated ventrally and the fascia intercarotica (FI) and the vagina carotica (VC) are exposed (a). (b) Partial resection of the VC shows the red latex in the 'danger space'. Dorsally, the green latex is visible underneath the fascia prevertebralis (FPV) in the prevertebral space

Therefore, we must examine closely and compare the two previously mentioned nomenclatures (Table 1). This paper adheres to the above defined 'Central-European terminology'. The classification used can be found in the textbook of topographical anatomy written by Hafferl (1969) and is similar to the description of Grodinsky and Holyoke (1938). In addition, it should be noted that a special embalming fluid is used at the Division of Macroscopical and Clinical Anatomy in Graz. Thiel's method is a globally recognized preservation method which gives the cadavers a lifelike condition, tissue behaviour, colour, and flexibility comparable to that of living tissue (Thiel, 1992b; 2002; Joy *et al.*, 2015). The flexibility of the cadavers is a crucial advantage because the fascias can be extended. As a consequence, the fascias are easy to identify for accurate dissection and for very precise evaluation.

Knowledge of the fascias and spaces of the neck and their topographical relations is very important for clinicians in different fields, all of whom should ideally follow and accept a common nomenclature. But we have documented differences in the terminologies used. Authors naturally tend to follow the international terminology (Federative Committee on Anatomical Terminology, 1998; 2011), which exacerbates the problem, as the international terminology does not list two important fascias: the fascia cervicalis media and fascia intercarotica. Neglecting or ignoring the existence of the fascia intercarotica suggests that there should be a direct connection of the pretracheal space to the 'danger space' via the retropharyngeal space. But the dissections demonstrated in this paper indicate that the fascia exists; it is neither an academic proposal nor a virtual structure but an easily dissectable anatomical plane of dense connective tissue. Grodinsky and Holyoke described a complete layer connecting the carotid sheath which lies between the visceral and prevertebral layer of the cervical fascia, and named it 'alar fascia' (Grodinsky and Holyoke, 1938). Recently, this fascia was confirmed by Gavid, who dissected both the alar fascia as well as the fascia prevertebralis (FPV). Unfortunately, Gavid did not mention the German interpretation of the fascias of the neck mentioned by Hafferl. In any event, we fully support and confirm the findings of Gavid *et al.* (2018) and Grodinsky and Holyoke (1938). In more recent literature, such as Gray's Anatomy, the author strictly follows the international terminology, and thus ignores both the fascia intercarotica and fascia cervicalis media (Gray, 1973). In the 41st edition of Gray's Anatomy (Gray, 2016), the alar fascia is mentioned as being ventral to the prevertebral layer of the

deep cervical fascia, fusing at the transverse process of the cervical vertebra. However, any possible connection of the alar fascia is not mentioned, although it is clearly confirmed by Gavid *et al.* (2018), Feigl (2015) and the current paper. So, it is clear that Gray's description concerning the spaces, especially the 'danger space' and retropharyngeal space, is confusing in terms of limitations and connections. In contrast, Hafferl lists the fascia intercarotica but does not mention the alar fascia (Hafferl, 1969). We should note that the latter textbook indicates the manuscript of Grodinsky and Holyoke (1938) but changes the term from alar fascia to fascia intercarotica for no known reason. Although the fascia intercarotica is known in the German literature, many atlases in the German language ignore it (Benninghoff and Drenckhahn, 2004; Lanz and Wachsmuth, 1955; Platzer, 1987; Prometheus, 2005; Putz and Pabst, 2000; Stecco, 2015; Tillmann, 2005).

The fascia alaris in our findings is a sagittal septum which corresponds to the findings of Charpy, who named these structures 'cloisons sagittales' (Charpy, 1912). Dean interpreted this fascia as the 'ala fascia' (Dean, 1919). Clearly, there is slight confusion regarding the terms alar fascia and ala fascia. As a consequence, we recommend adoption of another term to avoid this confusion. As this fascia is a connection between the vagina carotica and FPV, the term 'septum sagittale cervicale' or 'septum sagittale cervicis' would be more logical.

Additional recent publications have emerged from a research group in New Zealand. The information and interpretation of the fascias by Guidera *et al.* (2012) is based on the comparison of different publications, relevant texts from books of Radiology, Head and Neck Surgery, Plastic Surgery, General Surgery, and Otorhinolaryngology of the Australian reading lists for specialist training schemes. The principal language in this geographical area is English, and the authors did not review any textbook written in other languages. Therefore, one serious problem arises: the authors did not include German or French literature, which contains a great deal of important information about the crucial existence of the fascia intercarotica. It is clear that the authors had some problems in interpreting the alar fascia of Grodinsky and Holyoke, as they state that this fascia either corresponds to the prevertebral layer of the cervical fascia or is an inconsistently mentioned fascia. Two years later, the same group published a manuscript in which the authors stated that the alar fascia is a division of the deep layer of the deep cervical fascia spanning the transverse processes and the carotid sheath (Guidera *et al.*, 2014), thus confirming the description of Hollinshead (1982). Confusion could arise because in this case the alar fascia would be oriented in the sagittal plane and would thus correspond to the fascia mentioned by Charpy (1912) as well as our fascia alaris, and not mentioned by Grodinsky and Holyoke (1938). In addition, we must take into consideration the method this research group used to collect their information and data. In the paper issued in 2014, they stated that they had conducted a MEDLINE search, and that the inserted illustration was created by the anatomy of E12 plastinated slices of one cadaver and from MRI images (Guidera *et al.*, 2012). An illustration based on a single plastinated specimen does not seem to provide a valid or proper analysis of this complex topic. Additionally, it is questionable whether the interpretation using such a method includes all important and relevant information. Although the authors performed a highly exhaustive literature research for the secondary manuscripts, failure to include German textbooks and misinterpretation of the descriptions by Charpy (1912) and Grodinsky and Holyoke (1938) means that crucial information is lacking. Therefore the review and most of the conclusions should be regarded critically.

As the most common embalming method is the classical technique using formaldehyde, it should be noted that formaldehyde creates very hard, inflexible cadavers, with no contrasts and with tissue behaviour that is far from that of living tissue. The embalming method used in Graz and the base for all data and interpretations presented in this manuscript is Thiel's method (Thiel, 1992b; 2002), which is globally acknowledged as the most accepted preservation method that offers tissue behaviour close to that of living tissue (Peuker *et al.*, 2001; Alberty *et al.*, 2002; Thiel, 2002; Schwarz *et al.*, 2003; Joy *et al.*, 2015). As a consequence, we can assure readers that no presented dissections are artefacts, created by artificial dissection, but dissections following the dense connective tissue layers and, in the case of opening of a space, smooth dissection by tweezers. In conclusion, our information and knowledge is based on direct proven evidence by dissection documented by photography. Moreover, the descriptions match descriptions of the spread of local anaesthetics and consecutive side effects or complications (Feigl *et al.*, 2006).

Nevertheless, there are still some unanswered questions, for example, regarding the craniocaudal extension of the carotid sheath. How often does the retropharyngeal space between fascia intercarotica and fascia visceralis really exist? Many more questions can be listed which can be answered by injections and dissections on specially preserved or fresh cadavers only, and compared with the clinical and radiological findings. This will be a task not only for anatomists but also for clinicians, working together to create a common language and valid terminology for general global use. In this paper, we have focused only on the discussion of cervical fascias because discussing the terminology of cervical spaces would exceed the length of the paper. A further paper dealing with the terminology of the spaces between the described fascias will be published soon.

TABLE 2 The six relevant cervical fascias in Latin and English terminology (graphically shown in Figure 1)

Latin term	English term
Fascia cervicalis superficialis	Superficial cervical fascia
Fascia cervicalis media	Middle cervical fascia
Fascia visceralis	Visceral fascia
Fascia intercarotica	Intercarotid fascia; Alar fascia
Fascia alaris	-
Fascia prevertebralis	Prevertebral fascia

5 | CONCLUSION

As a consequence of varying descriptions and terminology used for anatomical structures of the neck, the medical advice based on this core knowledge is insufficient. In our opinion, the differences of anatomical nomenclature between Anglo-American and Central-European medical study are the underlying reasons for this problem. In terms of clinical applicability, we propose a terminology of the cervical fascias as shown in our dissection and drawings (Figure 1, Tables 1 and 2). Malgaine noted in his works in the 19th century that '...the cervical fascias appear in a new form under the pen of each author who attempts to describe them' (Lanz and Wachsmuth, 1955; Benninghoff and Drenckhahn, 2004). We do not want to invent anything new. The aim of this paper was to sensitize every clinician and anatomist dealing with cervical fascias to the existing confusion about basic morphological terms in the neck, and we wanted to solve this—as labelled by Natale *et al.* (2015)—anatomical proteus. Consequently, the international anatomical and ENT societies should create a unified anatomical nomenclature of the cervical fascias (and spaces) to prevent varying interpretations in the future.

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CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTIONS

GCF: manuscript preparation, data collection, dissections, photos, study design. GPH: data collection, dissections. RL: data collection, manuscript preparation, review. DK: manuscript preparation, review.

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